commercial software packages exist (*see* A Computer Aided Engineering

Workstation for Registration Control, E. McFadden, C. Ausschnitt, SPIE Vol. 1087,

255:266 1989; Matching of Multiple Wafer Steppers for 0.35 Micron Lithography

using Advanced Optimization Schemes, M. van den Brink, et al., SPIE Vol. 1926,

189:207, 1993, (hereinafter Klass II)) that model and statistically determine the

*A1* relative magnitude of the systematic and random inter-field and intra-field error

components for the purpose of process control, projection lens adjustment, wafer

stage calibration, and exposure tool set-up.  Other methods such as described in

U.S. Patent No. 5,978,085 and U.S. Patent No. 5,828,455 both entitled

"APPARATUS, METHOD OF MEASUREMENT, AND METHOD OF DATA

ANALYSIS FOR CORRECTION OF OPTICAL SYSTEM" to Adlai Smith, Bruce

McArthur, and Robert Hunter, and both incorporated in their entirety herein, use

overlay techniques to determine the lens aberrations of the photolithographic

exposure tool or machine.

**Please replace the paragraph at page 4, lines 6-16, with the following:**

For some applications, such as very high rate overlay sampling on

semiconductor production wafers, overlay registration results are not that sensitive

to the exact sampling in terms of target position and other parameters.  For

example, a typical semiconductor manufacturing facility might, for purposes of

process control, monitor the day to day alignment accuracy of an photolithographic

*A2* tool by measuring a small number of overlay targets on a small group of production

wafers, see for example Figures 14(a), 14(b), 14(c) and 15(b).  *See* Semiconductor

Pattern Overlay, N. Sullivan, SPIE Critical Reviews Vol. CR52, 160:188; Super

Sparse Overlay Sampling Plans:  An Evaluation of Methods and Algorithms for

Optimizing Overlay Quality Control and Metrology Tool Throughput, J. Pellegrini,

SPIE Vol. 3677, 72:82, 36220.

**Please replace the paragraph at page 8, lines 5-6, with the following:**

Figures 5(b1) - 5(b4) are a schematic diagram showing typical overlay errors associated with prior art systems.

**Please replace the paragraph at page 9, lines 2-3, with the following:**

Figures 14(a) - 14(c) are a schematic showing a prior art overlay exposure patterns for process monitoring and stepper qualification.

**Please replace the paragraph at page 11, lines 14-22, with the following:**

Conventional methods for collecting overlay data include programming an overlay tool with a set of software instructions that instruct the overlay tool to measure the alignment attributes or overlay targets in a distinct order, see for example Figures 14(a), 14(b), 14(c), 15(a), 15(b), and 15(c). The labeling and identification of the overlay output data usually depends on the type of overlay tool used to measure the alignment attributes. For example, the KLA 5100 series of tools use a complicated coding system that requires a fair degree of interpretation to decode the output data. *See* KLA 5105 overlay brochure, *supra*; KLA 5200 overlay brochure, *supra*. Other tools, like the BioRad Quaestor-Q7 simply label the output data by position, matching each registration error to its unique field point.

**Please replace the paragraph at page 12, lines 1-18, with the following:**

Most overlay tools are programmed to measure the alignment attributes in close proximity of many other similar looking features. Typically, overlay tools use an optical recognition routine to identify each alignment attribute just prior to measurement. Sometimes, the optical recognition system can read the wrong alignment attribute or a similar looking feature in a systematic way. If it is simply assumed that the overlay tool has identified the correct alignment attribute and one proceeds to use the program for production measurements, the data can become corrupt. In addition, many times the alignment attributes and wafer exposure patterns are symmetric with respect to the notch of the wafer, as illustrated in

Figures 14(a), 14(b) and 14(c). The symmetry can cause confusion when trying to set-up and debug the overlay machine instructions to read the alignment attributes in a unique order. For most production applications, unorganized, missing and slightly corrupt overlay data can be accounted for. For example, most production overlay routines measure the alignment attributes wafer-to-wafer and use statistical techniques to determine the average amount of overlay error associated with the production lot as a whole, thus missing and unorganized overlay data is accounted for statistically. While averaging data reduces the effect of erroneously identified data points, averaging data is not desirable because it can reduce the accuracy of the result. It is therefore desirable to have a technique that can eliminate these errors.

**Please replace the paragraphs at page 18, line 22 through page 20, line 3, with the following:**

A fourth encoding scheme example can be used to monitor the performance of the overlay tool in regards to special photolithographic process induced effects that corrupt the overlay data in a unique way. Typically, a critical dimension (CD) diminution in an "egg crate" structure across each field point is observed, see for example Figures 5(b1), 5(b2), 5(b3) and 5(b4). If the overlay job deck does not account for these process induced CD variations the overlay tool might read incorrectly as it steps target to target across a given field point array. In particular, instead of measuring the offsets relative to the egg-crate centerline, we may be measuring it relative to the edges which when combined with the above-mentioned CD variation will lead to erroneous results. To identify and correct these problems the reticle pattern is deviated by forcing the CDs of the outer frame structures to decrease as a function of the position within the field point array according to equations (6) and (7), and illustrated in Figure 5(a). For this encoding scheme the CDs of the horizontal and vertical bars that define the outer frame structure are modified, for example reduced, as a function of the position across the field point in ~10nm steps.

The CD diminution effect usually shows up as the wrong result in the overlay data for those overlay tools/jobs that are sensitive to this particular CD variation, e.g. overlay jobs that have been incorrectly set up. Thus as illustrated in Figure 5(c), an inner box is perfectly centered (offset=0) between two lines with different CD's when the overlay job is set up correctly to make a bar-in-bar type measurement. While in Figure 5d, the same alignment attribute will now produce a non-zero offset when set up (incorrectly) as a bar-in-box measurement. Figures 5(b1), 5(b2), 5(b3) and 5(b4) further illustrate this diminution error and how it might introduce overlay noise. For the example of frame-in-frame structures, an overlay tool or job deck that is not sensitive to these CD variations will measure only the programmed offsets from encoding scheme Example (3) described above and illustrated in Figures 5(a) and 5(b1), 5(b2), 5(b3) and 5(b4). Therefore, if the overlay tool produces incorrect measurements in a pattern that matches our fourth encoding scheme the overlay job deck will have to be modified to account for the diminution effect.

## REMARKS

Any fees that may be due in connection with this application throughout its pendency may be charged to Deposit Account No. 50-1213.

The specification is amended to adjust the references to Figures 5(b) and 14 to reflect corrections to these drawing figures. No new matter has been added to the specification.

///

///

///